MODULAR AIR-LAYERING AND CHEMICAL TREATMENTS IMPROVE ROOTING OF LOBLOLLY PINE

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Abstract. A new, rapid, standardized air-layering system, in combination with several chemical formulations applied to the branch girdles, gave over 60 percent rooting and survival of 8-year-old loblolly pine.

INTRODUCTION

With present methods, cuttings of most forest tree species are difficult to root. Finding the right combination of rooting technique and root-promoting chemicals is essential for improving rooting success. This paper describes the combination of an improved air-layering method with several chemical formulations not previously tested on girdles for rooting loblolly pine air layers.

Rooting techniques. With conventional rooting techniques for cuttings, decreased photosynthesis and lack of food reserves cause pine foliage to age prematurely and turn yellow, and the cuttings to die. Rooting can be improved in a growth chamber with enriched CO_2 and long days of high light intensity (4), but this method is expensive and unsuitable for operational production.

Since 1955 it has been known that girdling to increase food reserves in pine shoots can improve rooting success (13). A more recent procedure is to girdle the branch 1 to 2 months before taking the cutting, apply a rooting powder paste, and wrap with saran and foil (5). Photosynthates and growth regulators, not translocated out of the shoot via the severed phloem, accumulate above the girdle, inducing callusing and rooting. In pines (5,9,10) and hardwoods (6,7,8), this method has greatly improved rooting.

However, girdled cuttings rooted in the greenhouse are frequently difficult to establish. Roots are usually sparse and some may be broken when removed from the propagating bed. Also, this branch girdling method requires expensive greenhouse mist-propagation facilities.

Mergen (13) was the first to use conventional air-layering for rooting pines. But sealing polyethylene against the stem is difficult and the moss may dry out, or it may get too wet from rain running down the stem. A saturated medium causes shoots to decay, and excessive drying kills the roots. A better sealing film and a standardized amount of moisture-holding rooting medium were needed.

In preliminary experiments with slash pine (*Pinus elliottii* Engelm. var. *elliottii*), I compared several rooting media and wrapping materials for air-layering. Kys-Kubes[1] (Keyes Fibre Company, New Iberia, Louisiana) were selected as the rooting medium because they gave more rooting and less mortality, and they were easier to apply than cellulose blocks (BR-8, E.C. Geiger, Harleysville, Pennsylvania), pressed peat (Jiffy-7, E.C. Geiger, Harleysville, Pennsylvania), sphagnum moss, or vermiculite-perlite. The BR-8 held too much water and, except Kys-Kubes, the others dried out too rapidly. Kys-Kubes are pressed growing-blocks of peat, vermiculite, and cellulose fibers. Parafilm (Curtin Matheson Scientific, P.O. Box 53387, New Orleans, Louisiana), a highly flexible, self-sealing, waterproof laboratory film, sealed better than saran or polyethylene film.

Root-promoting chemicals. Chemicals that promote rooting include auxins, phenolic cofactors, and growth retardants for root initiation, sugars for root growth, and fungicides for inhibiting growth of microorganisms causing basal rot. A formulation from these classes of chemicals in a 1-1-10-10-1 ratio powder (IBA[2], PPZ, powdered sucrose, captan, and daminozide) improves rooting of ungirdled pine cuttings in a growth chamber (6). The formulation also helps rooting of girdled cuttings in the greenhouse when the powder is applied to the girdle (7). Later unpublished experiments indicate that a 1-1-20 (IBA-PPZ-sucrose) formulation is more effective than the 1-1-10-10-1 powder on the girdle (data available on request). Apparently captan and daminozide are not beneficial when applied to the girdle.

For the present study, I tested the hypothesis that adding PPZ and IBA would improve rooting over IBA alone applied to the girdle, that also adding sucrose would improve rooting over IBA-PPZ, and that one or more of 10 chemicals added individually to IBA-PPZ-sucrose powder would improve rooting even more.

MATERIALS AND METHODS

In early June 1979, five terminal branches in the lower crown of 8-year-old loblolly pines (*P. taeda* L.) growing in south Mississippi were tagged for girdling. Only vigorous branches well exposed to the sun were selected. The experi-

[1] Use of trade, firm, or corporation names is for the reader's information and convenience. Such use does not constitute official endorsement or approval by the U.S. Department of Agriculture to the exclusion of any other suitable product.

[2] See appendix for abbreviations and sources of chemicals.

mental design was completely randomized, with 24 treatments (rooting powders), four trees (replicates) for each treatment, and five girdled shoots on each tree — 480 air layers, 20 per treatment. Rooting powders were prepared by methods described in earlier studies (5,9). Each rooting powder was assigned to four trees at random. The 24 treatments comprised various combinations of IBA, IBA + PPZ, IBA + PPZ + SUC at two levels, and IBA + PPZ + SUC + one of 10 other chemicals (see appendix). The 10 chemicals used were tested at two levels, generally at 5 to 10 times the optimal concentration found when chrysanthemums (*Chrysanthemum morifolium* Ramat.) were used as a rapid bioassay (manuscript in preparation; data available on request).

For the modular air-layering method, I stripped away about 3 inches of needles about 10 inches below the terminal bud, removed a 1-inch ring of bark, coated the distal cut surface with an aqueous slurry of the appropriate powder on a camel hair brush, covered the treated girdle with a split, moistened Kys-Kube, and wrapped the Kys-Kube with Parafilm and then foil (Figures 1-6). Before being applied, Kys-Kubes were soaked overnight in water and then split on one side with pruning clippers, and the excess water was squeezed out. The Kys-Kubes were then opened like a book, placed over the treated girdle, closed, and sealed tightly against the stem with an 8-inch length of 4-inch-wide Parafilm. To reduce solar heating, I covered the Parafilm layer with a 5 × 9-inch strip of heavy duty aluminum foil. I applied the 480 air-layers in 2½ days, about 2 minutes per layer.

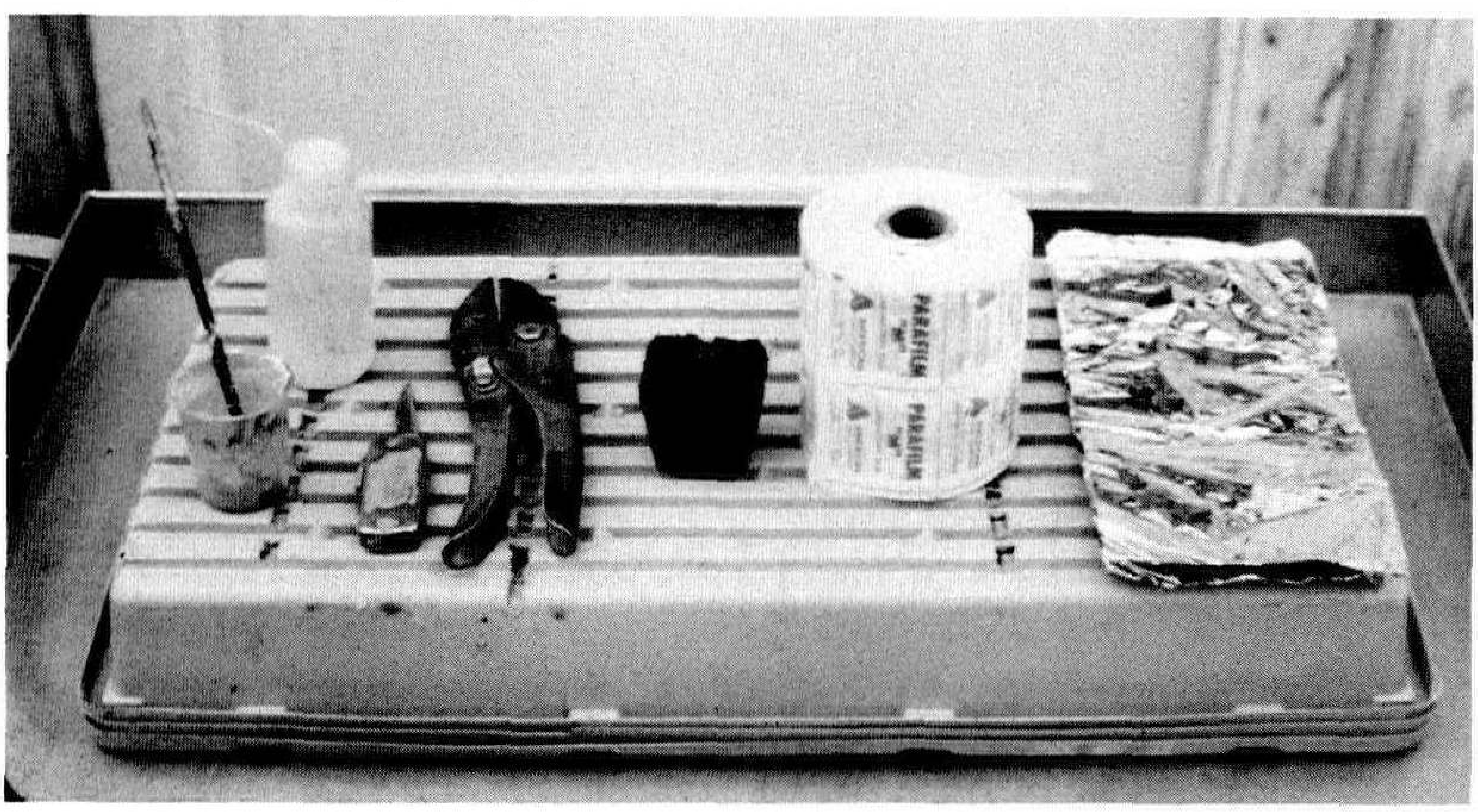

Figure 1. Materials needed in the field for modular air-layering. *Left to right:* rooting powder slurry with camel hair brush, water bottle for wetting slurry as it dries, pocket knife for making girdle, clippers for splitting Kys-Kube, moistened half-split Kys-Kube, Parafilm, and foil.

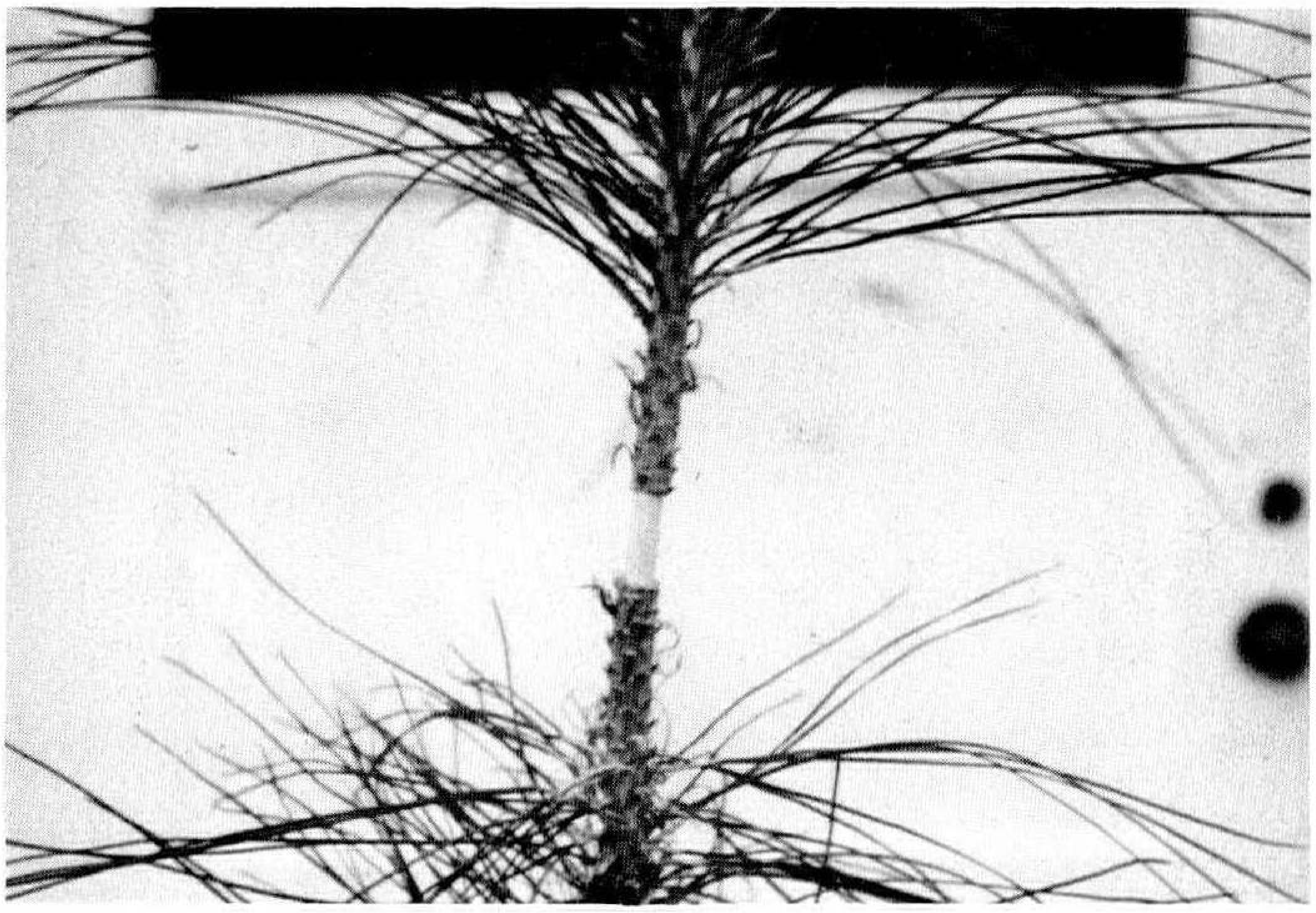

Figure 2. Girdled pine shoot.

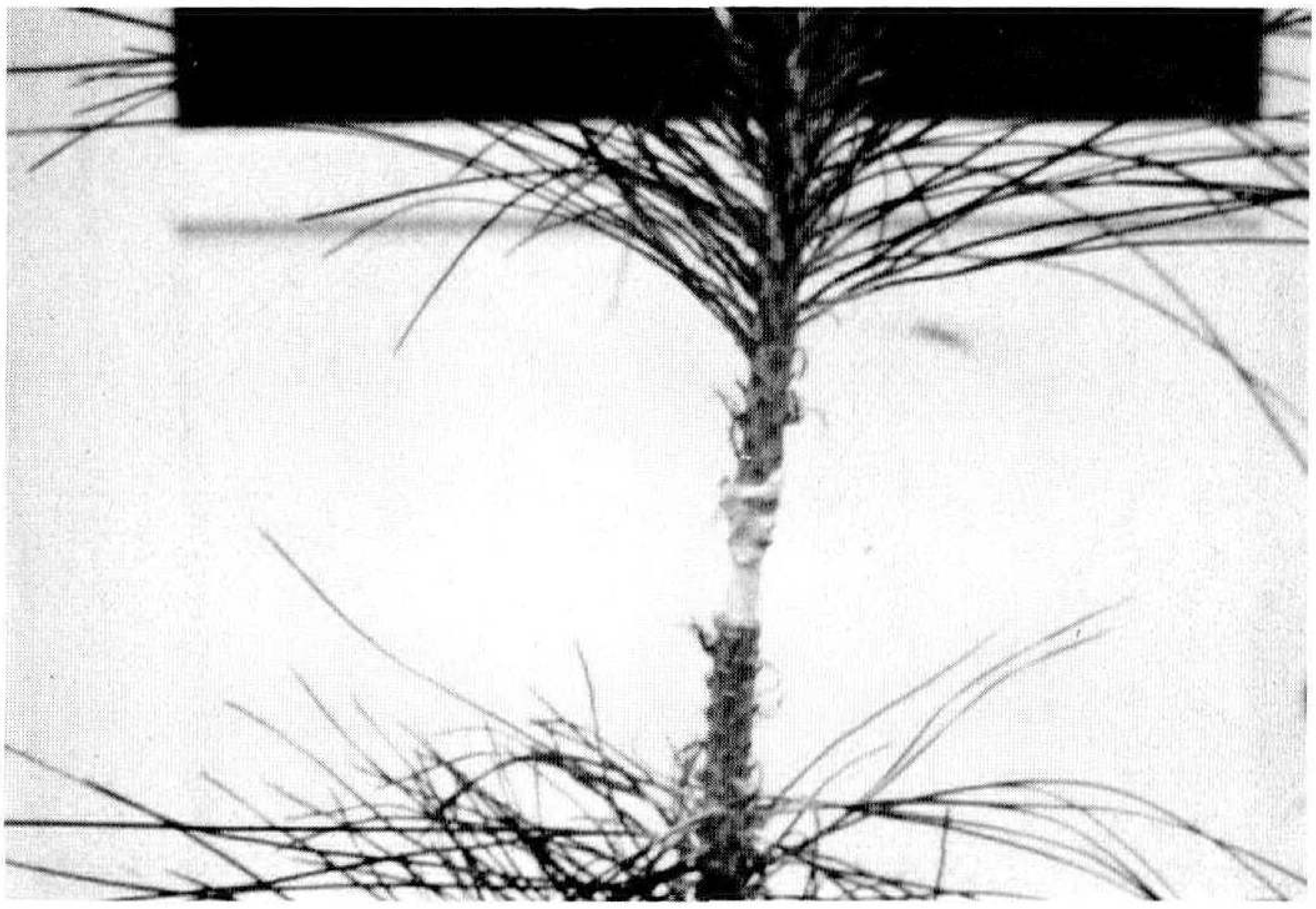

Figure 3. Rooting powder slurry applied to upper girdle.

After 2, 3, and 5 months, when roots appeared either under or penetrating the Parafilm, I severed the cutting just below the Kys-Kube. The foil was carefully removed, but the Parafilm was not disturbed where roots had penetrated it. Rooted cuttings were planted directly in an outside bed containing equal parts of peat, vermiculite, and perlite. Light sprinkling and shade, provided as a precaution to prevent excessive drying, were discontinued after 10 days, when roots had become established. Plants were given biweekly fertilization with 50 g soluble 20-20-20 fertilizer plus 1 g trace element concentrate dissolved in 20 l water.

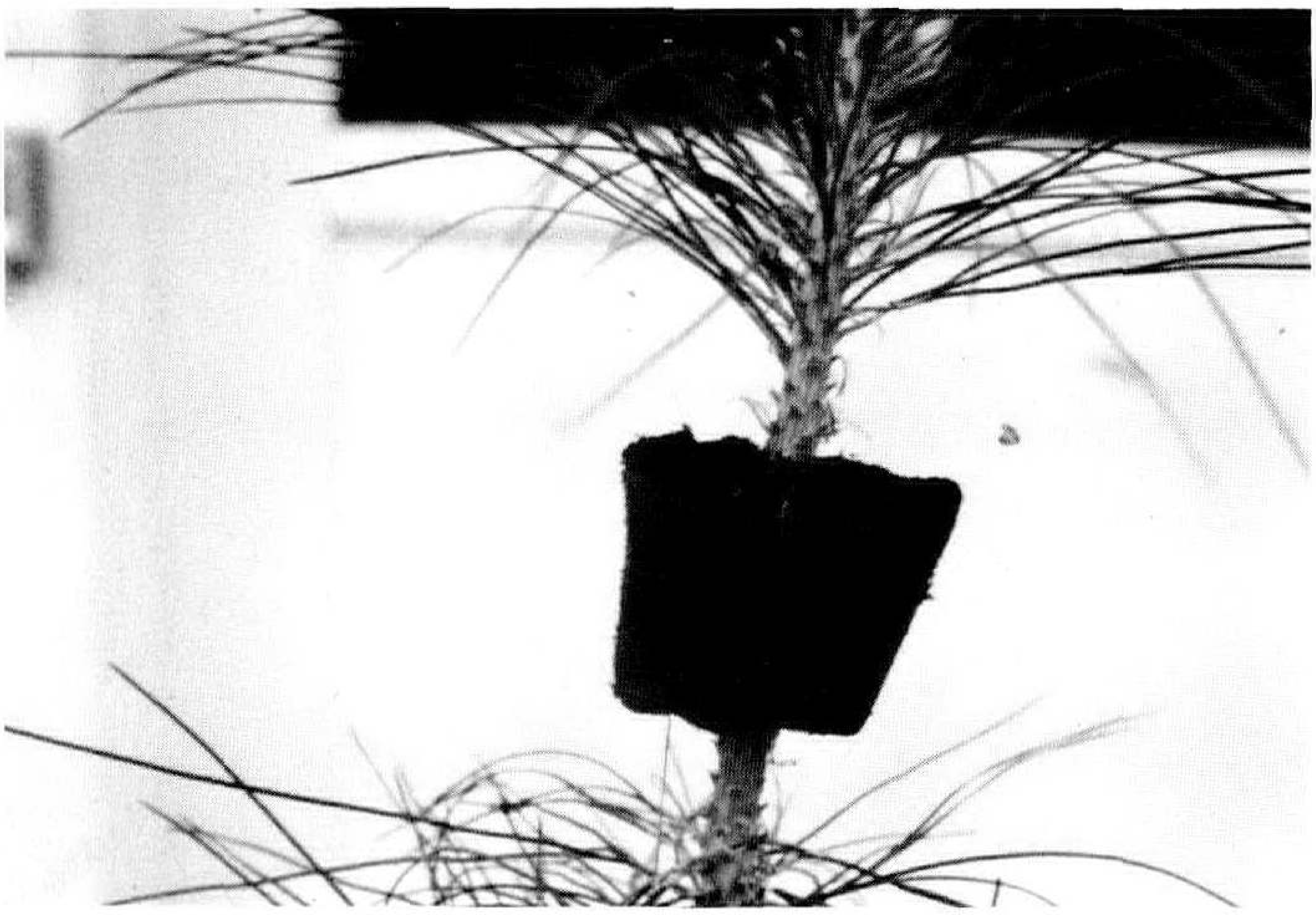

Figure 4. Half-split moistened Kys-Kube applied over treated girdle.

Figure 5. Kys-Kube wrapped tightly with Parafilm.

Two unusual events added unexpected variation to the experiment. Hurricane Frederic broke off 88 (18 percent) of the branches before they had rooted. Also, birds pecked holes in the foil and Parafilm on many of the girdles. This allowed rain to saturate the medium, killing 179 (37 percent) of the girdled branches. To be conservative, I eliminated only those branches affected by the hurricane from the analyses.

RESULTS AND DISCUSSION

Of 392 air-layered branches unaffected by the hurricane,

Figure 6. Final wrap of aluminum foil.

196 (50 percent) rooted and an additional 17 (4 percent) were still alive after 5 months. Despite extensive shoot death, over 70 percent rooting was obtained with 1-1-20 (IBA, PPZ, sucrose) plus either cortisol, pyrogallol, Stemtrol, or chlorogenic acid (Figure 7). Both PPZ and sucrose added to IBA appeared to in-

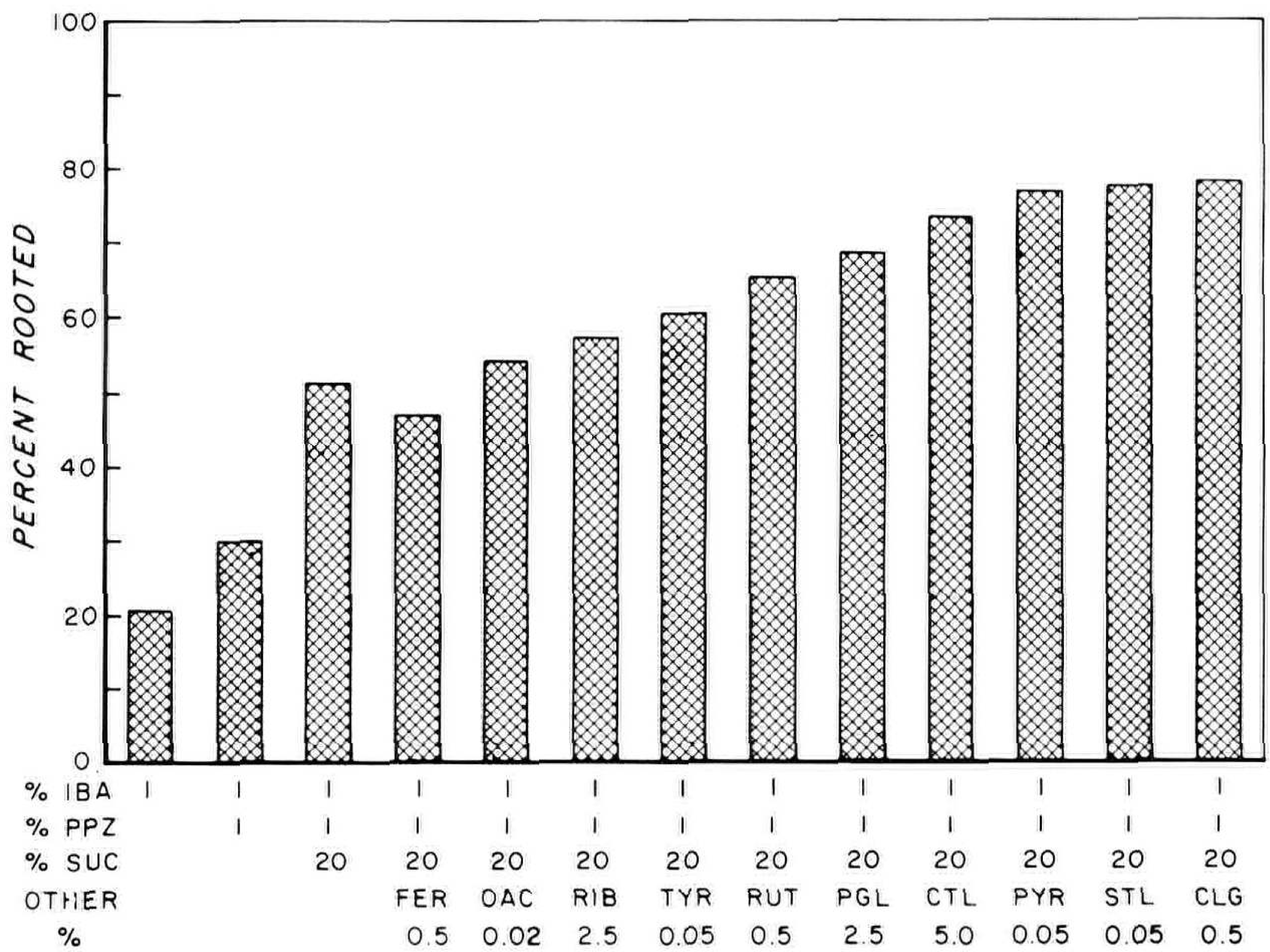

Figure 7. Rooting response by treatment. Girdled branches broken by wind omitted in calculation of rooting percentages.

crease rooting over IBA dose. Phloroglucinol, rutin, and tyrosine seemed to increase rooting over the 1:1:20 treatment also.

Most rooted air-layers had extensive root systems (Figure 8) and became established rapidly after planting, so misting and shading could be discontinued after 7 to 10 days. Overall survival (86 percent) in the nursery bed was much better than had previously been obtained with girdled cuttings from older pines. Cuttings that died were generally those that were brought to the nursery with small root systems. It appears important, therefore, to give ample time for an adequate root system to develop while the cutting is on the tree. Yet the cutting must be taken promptly when the root system is fully developed. otherwise the large root system soon dries out the Kys-Kube and roots die.

Figure 8. Well rooted cutting with roots extending from Kys-Kube.

This method of rooting pine is an improvement over the method I described in 1975 (5). The new method incorporates Mergen's (13) basic technique, chemical treatment improvements that have since been developed, and improved materials that control moisture levels.

Appendix. Abbreviations and names of chemicals mentioned in the text

Abbreviation	Chemical compound	Ref. No.
CLG	chlorogenic acid	15
CTL	cortisol (hydrocortisone)	12
FER	ferulic acid	15
IBA	indolebutyric acid	13
OAC	OAC 2582 (3-hydroxy-5-methyl-isoxazole)	14
PGL	phloroglucinol	16
PPZ[1]	1-phenyl-3-methyl-5-pyrazolone	4
PYR	pyrogallol	3
RIB	ribose	1
RUT	rutin	11
STL	Stemtrol (piproctanyl-bromide)	2
SUC	sucrose (10X confectioners sugar)	4
TYR	tyrosine	15

[1] Source: K & K Laboratories, Plainview, N.Y.

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TROPICAL FOLIAGE PLANTS FOR PROPAGATION

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The intent of this article is to provide an overview of the tropical foliage plant industry in Florida, indicate differences which exist between South Florida and Central Florida nurseries, mention some techniques of macro-propagation utilized for major groups of foliage plants and suggest plants which deserve more use in the industry.

UNIQUE ASPECTS

There are a few unique aspects of the foliage plant industry, particularly as they apply to the plant propagator. First there is very little documentation of propagation techniques for tropical foliage plants. One only has to review past Proceedings of International Plant Propagators' Society to discover the few papers which apply to tropical foliage plants. The same can be said for other journals such as the Journal of the American Society for Horticultural Science and HortScience. One of the most productive areas of the literature for information on certain groups of tropical foliage plants is within journals prepared by several plant societies. In most cases the commercial foliage plant propagator must conduct considerable research to determine the best techniques to propagate high quality plants most economically.

Little technology is available on tropical and semi-tropical seeds of ornamental plants. Propagators are particularly concerned with collection, storage and germination procedures best for tropical foliage plant seeds. Hopefully seed technology research can be encouraged where seed is collected and in locations where it is stored and germinated.

There is need for much taxonomic research to provide correct horticultural names for many foliage plants now in the trade. Of the 70 or so international registration authorities for